(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 037 090 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
20.09.2000 Bulletin 2000/38

(51) Int. Cl.[7]: **G02F 1/01**, G02F 1/313

(21) Application number: **00300896.8**

(22) Date of filing: **04.02.2000**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **12.03.1999 GB 9905733**

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(54) Optical switching arrangement

(57) Optical switching arrangement for switching a number of optical signals, consists of a thermo-optic switch having a number of heaters which are heated by passing electrical current through them. The mark-space ratio of current supplied from a constant voltage source is varied to provide constant power to the heaters to compensate for resistance changes in the heaters.

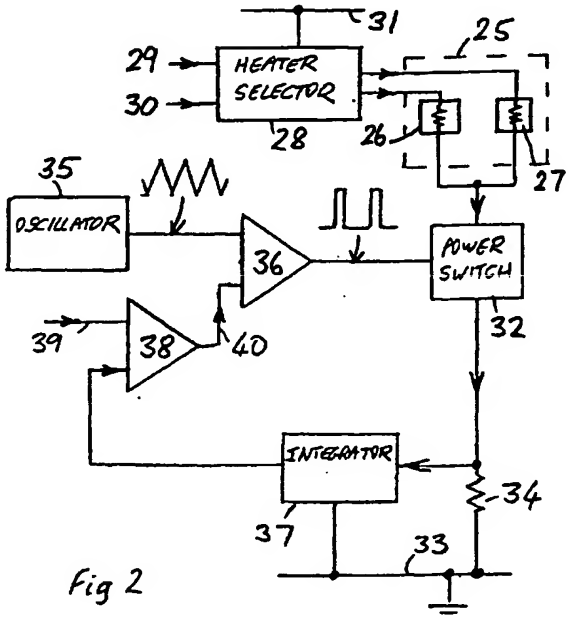

Fig 2

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Description

[0001] This invention relates to optical switching arrangements, and is particularly concerned with such arrangements which have temperature dependent switching elements. In order to achieve reliable switching, the temperature can be quite critical, but because such optical switching arrangements may include a large number of switching elements, there is a need for a simple but effective control mechanism which does not rely on measuring the operating temperature, and which does not require calibration of the individual switching elements.

[0002] According to this invention, an optical switching arrangement includes a thermo-optic switch having a plurality of heaters which are selectively energisable to route optical signals; means to apply a predetermined voltage to said heaters, and a power arrangement for applying pulsed current to energise said heaters, the mark-space ratio of the pulse current being variable to achieve a constant predetermined mean power value.

[0003] The invention is further described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows an optical switch, and
Figure 2 shows an optical switch arrangement in accordance with the invention which incorporates such an optical switch.

[0004] Referring to Figure 1, there is shown therein a four port optical switch, having two input ports 1, 2, and two output ports 3, 4, the switch in a first configuration providing a straight through path from input port 1 to output port 3, and from input port 2 to output port 4. In a second configuration, the connections are from input port 1 to output port 4, and from input port 2 to output port 3.

[0005] The input and output ports are interconnected by means of light guides 5, 6, 7, 8, having junction points 9, 10, 11, 12 which constitute switching elements and which are controlled by localised heaters 13, 14, 15, 16, 17, 18, 19, 20. The light guides comprise planar waveguides having a temperature sensitive refractive index, and the routing function of the optical switch is determined by operating one or other of the pair of heaters associated with each junction point. For this reason, such an optical switch is termed a thermo-optic switch. An example of such a switch is the solid state optical switch sold by Akzo Nobel by of the Netherlands.

[0006] Considering junction 9, light entering at port 1 is directed away from whichever junction arm has its heater energised, so that if heater 13 is energised, and heater 14 remains cool, the light is directed along light guide 6 to junction 12. Thus, to direct light from input port 1 to output port 4, and from input port 2 to output port 3, heaters, 13, 15, 18 and 20 are energised, with the other heaters 14, 16, 17, 19 being cool. Conversely, to allow light to pass straight through the optical switch, heaters 14, 16, 17, 19 are energised with the remaining heaters cool.

[0007] In practice, a number of optical switches of the kind shown in Figure 1 will be combined in a single package having a large number of input and output ports.

[0008] It has been found that the power supplied to the heaters needs to be precisely set to allow for tolerances in the characteristics of individual junctions and heaters. In an optical switching arrangement having a large number of junctions, it is undesirable, and possibly impractical to adjust the power levels individually, particularly as the thermal and electrical properties can change as the product ages.

[0009] Figure 2 shows an optical switch arrangement which incorporates an optical switch 25 of the kind shown in Figure 1, and a drive circuit which supplies precisely constant power to its heaters.

[0010] The two groups of heaters 13, 15, 18, 20, and heaters 14, 16, 17, 19 are represented diagrammatically by loads 26 and 27 respectively, the heaters within a given group being connected electrically in parallel. Selection of the appropriate load is by heater selector 28 in dependence on input signals on lines 29, 30. The heater selector 28 connects a precisely maintained voltage rail 31 at a contact predetermined voltage (typically 13 volts) to one or other of the loads 26 or 27. The current paths through the loads are combined at an electrical power switch 32 and returned to the ground voltage rail 33 via a low value sensor resistor 34.

[0011] The power switch 32 is an on-off switch with power amplification operating at a repetition rate of 30kHz, and having a variable mark-space ratio which is adjustable so as to maintain constant power consumption in the loads 26, 27. The repetition rate is determined by a triangular wave oscillator 35, and is chosen in relation to the thermal mass of the loads, so as to be above the frequency at which the temperature of the loads can respond, so as not to impart modulation to light signals passing through the optical switch.

[0012] The triangular waveform at 30kHz is applied to one input of a comparator 36, the other input of which receives a variable threshold level 40. Thus, by altering the threshold level, the mark-space ratio at the output of the comparator is varied.

[0013] The current flowing through the sensor resistor 34 is determined by integrating the voltage drop across it by integrator 37. The value of resistor 34 is very low, typically 0.5Ω, whereas the value of each load 26, 27 is typically about 200Ω, so that negligible power is lost in the sensor resistor 34. The output of the integrator 37 is compared at a comparator 38 with a preset reference value 39, and the output of the comparator 38 is proportional to the difference between the inputs, and this varying level output signal constitutes the variable

threshold level 40 for comparator 36.

[0014] Thus, the circuit is operative to maintain at a constant value the power applied to the loads, despite variations in resistance of the loads due to thermal changes and aging. The power level is selected so as to lie in the centre of the tolerance band of typical heaters, so that it is not necessary to individually adjust the characteristics of the circuit to each heater, whilst ensuring precise and reliable operation of the optical switching arrangement over an extended period of time.

Claims

1. An optical switching arrangement including a thermo-optic switch having a plurality of heaters which are selectively energisable to route optical signals; means to apply a predetermined voltage to said heaters, and a power arrangement for applying pulsed current to energise said heaters, the mark-space ratio of the pulse current being variable to achieve a constant predetermined mean power value.

2. An arrangement as claimed in Claim 1 and wherein a current sensor is provided in series with a plurality of said heaters.

3. An arrangement as claimed in Claim 2 and wherein the heaters are arranged in groups, with said current sensor being common to these groups.

4. An arrangement as claimed in Claim 1 or 2 and wherein means are provided for adjusting the mark-space ratio in dependence on the mean current passing through said current sensor.

5. An arrangement as claimed in Claim 2, 3 or 4 and wherein said current sensor comprises a predetermined resistance value which is small relative to the resistance of a heater.

6. An arrangement as claimed in Claim 4 and wherein an integrator is provided to produce a signal representative of said mean current.

7. An arrangement as claimed in any of the preceding claims and wherein the period of the repetition rate of said pulsed current is substantially shorter than the rate at which the temperature of a heater is able to respond to changes in power applied to it.

8. An arrangement as claimed in Claim 7 and wherein the repetition rate of said pulse current is constant.

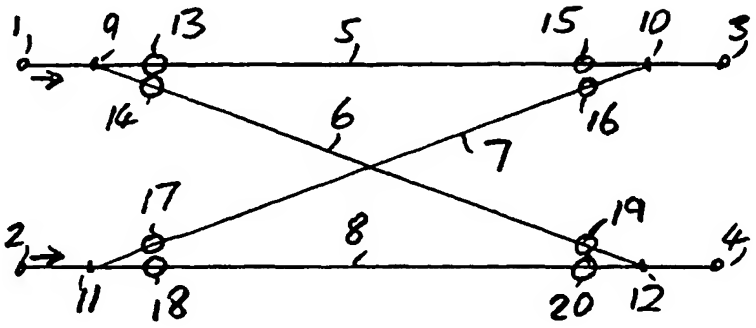
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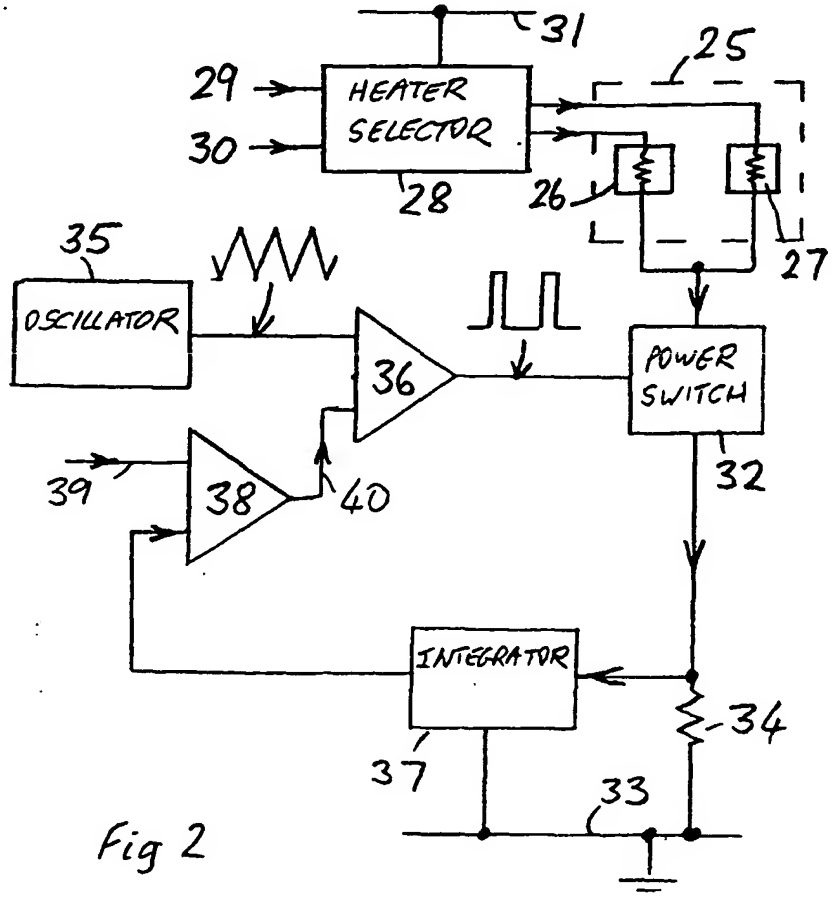
Fig 1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HEATER SELECTOR
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OSCILLATOR
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POWER SWITCH
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INTEGRATOR
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37
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Fig 2